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# Efficiency Comparison of Mechanization Techniques in Nursery

**Tugrul Varol*, Halil Baris Ozel, Tuna Emir, Recep Ozdil**

Bartın University, Faculty of Forestry, 74110 Bartın, Turkey

## Abstract

In this study, the five-stage mechanization techniques applied in the production of seedlings at the Gökçebey Nursery Department were compared with the activities carried out using manpower. These stages are soil tillage, preparation of seeding beds, sowing, maintenance of seedlings and uprooting of seedlings. During the production of seedlings of 2 + 0 aged, Tefen origin in Gökçebey nursery, unit time analyzes were performed with 30 replicates. The most efficient activity in terms of manpower was the preparation of pillows with 60%, followed by tillage (84), maintenance (59%), seedling (52%), planting (46%), and tillage (39%). Furthermore, the economics of mechanization according to manpower was examined by Break-even analysis. According to the results, it was determined that machine operation is more economical in case of carrying out 157 soil cultivation annually, preparing 158 seeding beds, planting 310 seeding beds, performing maintenance on 218 seeding beds and performing seedling dismantling activities in 182 seeding bedsowing cushions. According to the examinations and evaluations made, the use of appropriate mechanization techniques positively affected and supported the nursery production activities because of the fact that it ensured shorter time, healthier and lower costs, production with a minimum loss, and uninterrupted production. Utilization of appropriate mechanization techniques determined in accordance with the necessary criteria at the seedling production stages and rehabilitation works in order to ensure the contribution to the forest areas, which are now destroyed due to various reasons, to the national economy, and to realize the forestry policies and targets in a timely manner, will always increase the success, and it will create an important opportunity for preventing a significant portion of occupational accidents that emerge while applying classical methods.

**Keywords:** Nursery, Mechanization, Manpower, Seeding bed, Soil tillage

## 1. Introduction

In Technical forestry practices are conducted by using site specific methods in different areas. In this sense, the methods should be evaluated in terms of ecological, economic and ergonomic efficiency criteria, and an appropriate solution should be determined in order to ensure that the natural resources are managed with a minimum loss and to carry out optimum production with low cost. This should be well evaluated and analyzed, especially in terms of silvicultural activities. In particular, it is necessary to decide the best method for seed and seedling production since the production activities, which are conducted under different environmental conditions, are carried out with different methods both at the nursery stage and the land stage, (Liegel and Venator, 1987; Ürgenç, 1998; Kelly and Wentworth, 2009; Güner et al. 2013). Within this context, depending on the equipment and technologies developed in the field of the nursery, equipment connected to different main power units have been utilized in many stages of production activities in recent years (Gammoh, 2011; Wang et al., 2015). Time analysis is usually carried out either when testing new equipment or testing the equipment under new conditions (Visser and Spinelli, 2012; Borz et al., 2015). Thinned seed sowing is used to grow larger spruce seedlings after 50-60 seed sowing at the sowing line and after sowing for three years. This technique has allowed reducing labor and material expenditure in Belarus (Osmolovskiy and Granik, 2014). In India, mechanized planting method increased the field capacity by 66.70%, field yield by 22.36%, seed sowing by 20.00%, grain yield by 16.76%, feed yield by 19.14%, saved work time by 66.40% and reduced the cost by 44.70% (Khobragade et al., 2011; Narang et al., 2016). However, in Turkey, it is not possible to come across the comparison of the production techniques and equipment used at different stages with the classical works done with manpower (Ürgenç, 1998; Hormozi et al., 2012). In fact, the same situation applies

*Corresponding author: Tel: +90 378 223 5171 E-mail: tvarol@bartin.edu.tr
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for regeneration, tending and afforestation works as well (Odabasi et al., 2004). In this study, a comparison was made between different equipment used in 2+0 bare-root seedling production activities carried out on seeding beds at Gökçebey Forest Nursery and the traditional manpower production activities by performing unit-time analyses. The unit-time analyzes (time studies) of the five activities (soil cultivation, sowing cushion preparation, sowing, seedling removal, seedling maintenance) were used to determine the efficiency level and economic limits of human and machine work.

## 2. Material and Methods

### 2.1. Study Area

The research was carried out in Gökçebey Forest Nursery Department of Zonguldak Regional Directorate of Forestry. Gökçebey Forest Nursery Department (Figure 1) was established in 1984 in an area of 701 decares, and it is located at 45 m altitude with northwest elevation and lower slope conditions. In seedling activities, the broadleaf seedling production is the top at list in Turkey.

Figure 1. A view from the nursery (Anonymous, 2019)

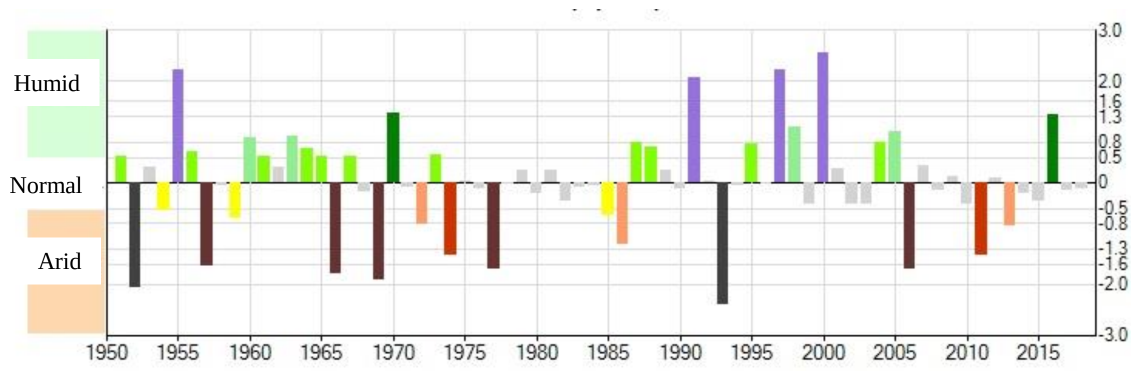
For afforestation activities, 2000000 broadleaf saplings, 500000 coniferous saplings, and 100000 decoration plants are produced each year. In the nursery, broad-leaved species such as beech, chestnut, walnut, wild cherry, sycamore, maple and European ash are produced as well as coniferous species such as fir, larch, pine and European nut pine. The annual production amount of the nursery is 5 million, and its realization rate is 80% per annum (Anonymous, 2019).

The area where the nursery is located has a drought value close to normal (determined by SPI-Standardized Precipitation Index) according to the average of many years (Figure 2). According to the 68 years of evaluation (1951-2019), 15 years of drought period was seen and the driest year was 1993.

### 2.2. Measurement and Analysis

In this study, practices were generally carried out in leaf seedling production plots. All studies were conducted on the seeding plots of 2+0 bare-root beech seedlings (Figure 3).

The unit-time analyses of the works conducted at each process stage using equipment and manpower were compared to each other, and the comparison of the results obtained was made using multi-variance analysis. The measurements were performed in 30 replicates in all nursery technique applications. In case of the emergence of significant differences in terms of statistical analysis as a result of comparisons made on the means, the groupings were performed with Duncan test at 95% confidence level. On the other hand, depreciation expenses were also calculated based on the purchasing costs of the equipment used according to the work stages. The cost per-unit-time was determined according to the calculated costs, and they were compared according to the methods.




| | Count | Percentage | | Count | Percentage |
|---|---|---|---|---|---|
| Extraordinary humid | 4 | 5.88 % | Slight arid | 3 | 4.41 % |
| Sticky | 0 | 0.00 % | Middle arid | 3 | 4.41 % |
| Perhumid | 2 | 2.94 % | Severe arid | 2 | 2.94 % |
| Middle humid | 4 | 5.88 % | Splitting arid | 5 | 7.35 % |
| Slight humid | 11 | 16.18 % | Extraordinary arid | 2 | 2.94 % |
| Normal | 32 | 47.06 % | Unclear | 0 | 0.00 % |

Figure 2. SPI values and realization percentages for the period 1951-2019

Figure 3. Beech seeding plots (Anonymous, 2019)

In the comparisons, Break-even analysis was utilized in order to determine the conditions, under which the work stages realized, using machine equipment would be more economical than those performed with the manpower (Varol and Özel, 2015). The following equation was used:

$$F_i+V_iQ=F_m+V_mQ \quad (1)$$

Q: the amount of work done,
$F_i$: fixed costs of nursery technique practice carried out using manpower,
$V_i$: variable costs of nursery technique practice carried out using manpower,
$F_m$: fixed costs of nursery technique practices carried out using machines,
$V_m$: variable costs of nursery technique practice carried out using machines.

The fixed costs taken into account in the calculations included depreciation, interest, insurance and operator and assistant (if any) fees, whereas variable costs included fuel costs, maintenance and repair costs and oil and lubrication costs.

## 3. Results and Discussion

The mean values and standard deviation values of the unit-time analyses performed with both manpower and machine equipment are given in Table 1. As it can be seen from Table 1, as well as the unit-times are lower in machine works as expected, the standard deviations at each stage are much lower than the works using manpower.

### 3.1. Soil Tillage

In a standard-sized plot included in the rotation plan, the soil tillage carried out with a 3-disc mouldboard plough attached to a rubber wheeled agricultural tractor and a 3-way ripper attached to a 4x4 wheeled forest tractor (Figure 4), as well as preparation of seeding beds using manpower were compared. As a result of the comparisons made with ANOVA, a statistically significant difference was found between the three methods at 99% confidence level. In this context, the results of the grouping made using Duncan test are given in Table 2. According to the data given in Table 2, the best method for soil tillage in terms of unit-time in a standard plot with 95% confidence level was found to be 3-way ripper attached to a forest tractor as a result of Duncan test, whereas the most inefficient method was found to be the soil tillage method using manpower with hand tools such as hoe and digger.

According to the Break-even analysis performed to make comparisons between manpower and machine power, the fixed and variable costs, were determined as: 67.20 TL/hour and 118.95 TL/hour for MBTRAC 900-mounted ripper; 60.40 TL/hour and 64.00 TL/hour for New Holland mounted plough; 48.38 TL/hour and 48.75 TL/hour for John Deere seeding bed preparation machine; 54.20 TL/hour and 40.20 TL/hour for John Deere sowing machine, and 43.28 TL/hour and 25.75 TL/hour for John Deere pulveriser, respectively (Table 3). The average soil tillage of an area of 100 x 100 m was completed by 20 workers in 3 hours and 43 minutes. Since the hourly wage of a worker was 13.20 TL/hour, $V_{iti}$=223x20x0.22=981.20, while annual fixed cost of forest tractor-mounted ripper was $F_{oti}$=67.20x2000= 134400 TL, its variable cost was $V_{oti}$=118.95/0.95 =125.21 TL/ha. Therefore, the difference between soil tillage done with forest tractor-mounted ripper and with manpower was found to be Q=(134400-0)/(981.2-125.2)=157.01 ha/year.

Table 1.Unit-time measurements and standard deviations

| Types of Activities | Number of trials | Average duration (s) | Standard deviation (s) |
|---|---|---|---|
| Soil tillage(Manpower) | 30 | 4660 | 1025 |
| Soil tillage (Machine) | 30 | 2124 | 38 |
| Preparation of seeding beds(Manpower) | 30 | 2144 | 958 |
| Preparation of seeding beds (Machine) | 30 | 875 | 30 |
| Seed sowing(Manpower) | 30 | 1222 | 355 |
| Seed sowing (Machine) | 30 | 383 | 15 |
| Maintenance of seedlings(Manpower) | 30 | 7592 | 1678 |
| Maintenance of seedlings (Machine) | 30 | 4432 | 84 |
| Uprooting of seedlings(Manpower) | 30 | 2486 | 789 |
| Uprooting of seedlings (Machine) | 30 | 1395 | 36 |

Figure 4. Soil Tillage

Table 2.Duncan Test Results of Soil Tillage Methods

| Type of Process | Unit-Time Analysis |
|---|---|
| 3-way ripper and a forest tractor[a] | 35 minutes 24 seconds |
| Agricultural tractor and3-disc mouldboard plough[b] | 57 minutes 31 seconds |
| Soil tillage with manpower[c] | 3 hours 43 minutes |

a, b, and c: Different letters refer to different groups

Table 3. Fixed and variable costs of the equipment (Varol, 1997)

| COST FACTORS | EQUIPMENT | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | MB-TRAC900-Mounted Ripper | | New Holland-Mounted Plough | | John Deere Seeding Bed Machine | | John Deere Seed Sowing Machine | | John Deere Pulveriser | |
| Purchase price (I) | 310000 TL | | 255000 TL | | 150000 TL | | 200000 TL | | 105000 TL | |
| Scrap value (R) | 31000 TL | | 25500 TL | | 15000 TL | | 20000 TL | | 10500 TL | |
| Amount to be amortized (I-R) | 279000 TL | | 229500 TL | | 135000 TL | | 180000 TL | | 95000 TL | |
| Depreciation time (N) | 10 year/20000 hours | | 10 year/20000 hours | | 10 year/20000 hours | | 10 year/20000 hours | | 10 year/20000 hours | |
| Average investment A=[(I-R) (N+1)/2N]+R | 337900 TL | | 277950 TL | | 163500 TL | | 218000 TL | | 115000 TL | |
| Interest rate | 10% | | 10% | | 10% | | 10% | | 10% | |
| | COSTS | | | | | | | | | |
| Fixed Costs | TL/hour | TL/min | TL/hour | TL/min | TL/hour | TL/min | TL/hour | TL/min | TL/hour | TL/min |
| Depreciation (I-R) /20000 | 13.95 | 0.23 | 11.47 | 0.19 | 6.75 | 0.11 | 9.00 | 0.15 | 4.75 | 0.08 |
| Interest (A)x0.10 /2000 hours | 16.90 | 0.28 | 13.90 | 0.23 | 8.17 | 0.14 | 10.90 | 0.18 | 5.75 | 0.10 |
| Expenses such as insurance etc.(I)x 0.03/2000 hours | 4.65 | 0.08 | 3.82 | 0.06 | 2.25 | 0.04 | 3.00 | 0.05 | 1.58 | 0.03 |
| Operator wage (wagex12)/2000 hours | 18.00 | 0.30 | 18.00 | 0.30 | 18.00 | 0.30 | 18.00 | 0.30 | 18.00 | 0.30 |
| Co-worker wage (wageX12)/2000 hours | 13.20 | 0.22 | 13.20 | 0.22 | 13.20 | 0.22 | 13.20 | 0.22 | 13.20 | 0.22 |
| SUM (1) | 67.20 | 1.12 | 60.40 | 1.02 | 48.38 | 0.82 | 54.20 | 0.92 | 43.28 | 0.72 |
| Variable Costs | TL/hour | TL/min | TL/hour | TL/min | TL/hour | TL/min | TL/hour | TL/min | TL/hour | TL/min |
| Fuel costs | 100.00 | 1.67 | 50.00 | 0.83 | 40.00 | 0.67 | 30.00 | 0.50 | 20.00 | 0.33 |
| Maintenance and repair costs (I-R) x10% /20000 | 13.95 | 0.23 | 11.47 | 0.19 | 6.75 | 0.11 | 9.00 | 0.15 | 4.75 | 0.08 |
| Oil and lubrication costs | 5.00 | 0.08 | 2.50 | 0.04 | 2.00 | 0.03 | 1.50 | 0.02 | 1.00 | 0.02 |
| SUM (2) | 118.95 | 1.98 | 64.00 | 1.07 | 48.75 | 0.81 | 40.50 | 0.68 | 25.75 | 0.43 |
| GENERAL SUM (1+2) | 186.15 | 3.10 | 124.37 | 2.09 | 97.13 | 1.63 | 94.70 | 1.60 | 69.03 | 1.15 |

This result indicates that in order for soil tillage with forest tractor-mounted ripper to be more economical than soil tillage with manpower, an area of approximately 150 hectares is required to be tilled annually. Considering the Gökçebey nursery with 70.1 ha area, it will be economical to till the soil using a forest tractor (MB TRAC900) mounted ripper if the soil in the nursery is tilled twice a year. When the same process is considered for the agricultural tractor (New Holland) mounted plough, the annual fixed cost was $F_{tti}$=60.40x2000 =120800 TL, while the variable cost is $V_{tti}$=64.00/0.95= 67.37 TL/ha. Therefore, the difference between soil tillage done with agricultural tractor-mounted plough and with manpower was found to be Q=(120800-0)/(981.2067.37)=132.19 ha/year. This shows that the plough coupled to the agricultural tractor will be more economical when the soil in the nursery is tilled approximately 1.8 times.

In a study conducted on this subject in the Swedish State Nursery, the soil tillage works carried out on seeding, planting and repikaj beds prepared on large nursery plots of 0.25 ha at the nursery stage were found to be 25.7% faster and 38.6% more efficient than other soil tillage methods, when carried out using forest tractor-mounted 3' and 2' flat rippers (Ersson, 2014). 162 ha/year with Bracke Patch Scarifier, 219 ha/year with Anchor Chain Draggs, and Ripper Plow with approximately 262 ha/year was found to be economic (Bamsey, 1985).

### 3.2. Seeding and Plantation Beds

Within the scope of the research, the second unit-time analysis was carried out for the preparation of seeding and plantation beds. The data obtained in this direction are given in Table 4. Unit-time analyses performed in bed preparation were determined in the preparation process of a standard bed with the dimensions of 100 m x 40 cm (Figure 5). As a result of the variance analysis applied to the obtained raw data according to randomized block design with 3 replications, a statistically significant difference was found between the processes at 99% confidence level during the bed preparation process. In this context, the results of the Duncan test, which is performed at 95% confidence level, are given in Table 4. When the data given in Table 4 is examined, it is determined that bed preparation with the machine is very efficient in the preparation of a standard seeding bed and that the processes are completed in a shorter time.

When the preparation of seeding beds with manpower and with the machine was compared to each other, fixed cost of the machine was found to be 48.38 TL/hours and the variable cost was 48.75 TL/hours. The preparation of an average seeding bed is completed by a person in 2 hours and 30 minutes. Since the hourly wage of a worker was 13.20 TL/hour, $V_{iey}$ = 150x20x0.22 =660.00 TL/bed, while annual fixed cost of forest tractor-mounted ripper was $F_{mey}$= 48.38x2000 = 96760 TL, with the variable cost of $V_{mey}$ = 48.75/1 = 48.75 TL/bed.

Therefore, the difference between soil tillage done with forest tractor-mounted ripper and with manpower was found to be Q = (96760-0) / (660.00-48.75) = 158.30 bed/year. This result indicates that in order for seeding bed preparation with a machine to be more economical than bed preparation with manpower, approximately 158 seeding beds should be prepared annually.

There is efficiency and profitability up to 60% in terms of time and cost in terms between seeding bed preparation processes with the machine and with manpower. In another study conducted in Sweden on this subject, it was determined that the equipment used in bed preparation processes, in repikaj operations and seedling uprooting works provided around 55.2-75.6% efficiency and low cost compared to classical methods (Ersson, 2010). Similar results were found by Elashry (1983).

Table 4. Duncan test results for unit-time studies applied in the preparation process of seeding beds

| Type of Process | Unit-Time Analysis |
|---|---|
| Bed preparation with manpower[a] | 2 hours 29 minutes 42 seconds |
| Bed preparation with machine[b] | 14 minutes 35 seconds |

a, b, and c: Different letters refer to different groups.


Figure 5. Preparation of seeding beds using manpower (left) and machine (right)

### 3.3. Sowing Process

The third practice, in which the unit-time analyses were performed, was the sowing process. In the sowing process, the sowing application carried out by 8 workers in 4 lines drawn at 25 cm intervals on a 100 x 100 m planting plot was taken into consideration (Figure 6). As a result of ANOVA applied to raw data regarding the unit-time studies performed according to different methods applied during the sowing process, a statistically significant difference at 99% confidence level was found between methods. In this context, the results given in Table 5 were obtained at 95% confidence level as a result of the grouping made using Duncan test.

When the unit-time study results given in Table 5 were examined, it was found that sowing with machine was very efficient, cost-effective and shortened the sowing time, which was of great importance in terms of seed germination energy and power in the sowing process that required significant time. It was found that the sowing process should be carried out on approximately 310 seeding beds per year, so the machine operation was more economical.

In a study, in which the production activities carried out at the nursery stage were examined, it was found that the applications made with the sowing machine during sowing activities carried out in a large area with 34 cm intervals on 120 x 100 m European beech and scotch pine seeding beds, 43.5% and 32.7% efficiency was achieved per-unit-time. In addition, in this research conducted in Finland, the contribution of seedling production by using mechanization techniques to the country's exportation was reported to be high (Laine, 2017). In the studies carried out by Ersson et al. (2018) using both tracked and wheeled excavators, sowing ranging between 150-265 per hour were realized. The results obtained from the studies conducted in Finland and Sweden in 2017 were similar to our study in which approximately 240 plantings were carried out per hour. The sowing process with the machine S 237 in Poland was found to be 33% more efficient than manpower (Osmolovskiy and Granik, 2014).

Figure 6.Sowing with manpower (left) and machine (right)

Table 5. Duncan test results for unit-time studies applied in the sowing process

| Type of Process | Unit-Time Analysis |
|---|---|
| Sowing with manpower[a] | 20 minutes 22 seconds |
| Sowing with machine[b] | 6 minutes 23 seconds |

a and b: Different letters refer to different groups.

### 3.4 The Maintenance of Seedlings

The fourth stage, in which unit-time analyses were performed, was the maintenance of seedlings carried out in 2+0 beech seedlings in the form of weeding, root resection and thinning. In relation to weeding stage on 100x100 m long seeding beds, weeding performed using tractor-mounted pulveriser and Glaypshate brand selective herbicide was compared with weeding performed by workers (Figure 7). Also, root resection performed by using a root-resection knife mounted on the agricultural tractor was compared to root resection performed by the workers using a manual root-resection knife, and the thinning process conducted using thinning blade mounted on the agricultural tractor was compared with thinning done by uprooting. Comparisons of unit-time analyses were made using ANOVA. Accordingly, differences were found between different methods used at 99.9% confidence level in weeding, 95% confidence level in root resection and 95% confidence level in thinning. Within this scope, the results of the Duncan test, which was applied at 95% confidence level in order to group the methods, are given in Table 6.

When the results in Table 6 were examined, it was determined that the machine operated processes were more efficient and more cost-effective in terms of unit-time analysis at every stage of seedling maintenance, which consists of 3 stages. When working with machine and with manpower are compared for seedling maintenance, it is determined that machine operated work will be more economical if maintenance work is carried out on approximately 218 seeding beds annually.

**a** **b** **c**

Figure 7.Pulveriser (a), root-resection (b) and thinning (c) equipment used during the seedling maintenance stage

Table 6. Duncan test results regarding the methods used in seedling maintenance processes

| Type of Process | Unit-Time Analysis |
|---|---|
| *Weeding* | |
| Agricultural tractor-mounted pulveriser[a] | 15 minutes 21 seconds |
| Weeding with manpower [b] | 37 minutes 43 seconds |
| *Root resection* | |
| Root-resection knife mounted on an agricultural tractor[a] | 27 minutes 36 seconds |
| Manpower (root-resection knife)[b] | 40 minutes 15 seconds |
| *Thinning* | |
| Thinning blade mounted on an agricultural tractor[a] | 32 minutes 55 seconds |
| Thinning with manpower[b] | 48 minutes 34 seconds |

a and b: Different letters refer to different groups.

In the processes carried out in special nurseries, which have very high production capacity in Finland, it was reported that the use of applications, in which the chemical and mechanization types are combined at the weeding and thinning stages accelerate the production process and cause an increase of at least 25.3% in seedling quality (Ersson et al., 2014).

The equipment mounted (Darwin 2000 and The Bonner) on tractors by Blanke (2010) in nurseries and the manpower intervals were compared. In the study, the tractor to which Darwin 2000 was connected was 5-10 km/h, and the tractor which was connected to the Bonner was moving at 4-8 km/h and the costs were 6-7 thousand € and 7-8 thousand €, respectively. As a result of the study, it was determined that Darwin 2000 and The Bonner equipment are more suitable than the use of manpower.

### 3.5. Uprooting of Seedlings

The last stage of the research, where assessments related to mechanization techniques applied in nursery conditions and the unit-time analyses were performed, was the uprooting of seedlings. In this context, mechanization application (Figure 8) and manpower methods for the uprooting of 1023 beech saplings, which were 2+0-year-old and Tefen originated, on a total of 4 seeding beds located in the plot no 7 of Gökçebey Nursery in September 2018 were compared. As a result of the comparisons made with ANOVA, a statistically significant difference at 99.9% confidence level was found between the uprooting procedures. Within this context, the results of the Duncan test, which was applied at 95% confidence level and aimed to group the procedures, are given in Table 7.

Figure 8. Seedling uprooting machine

Table 7.Duncan test results in relation to the methods used in seedling uprooting processes

| Type of Process | Unit-Time Analysis |
|---|---|
| Uprooting of seedlings with manpower [a] | 41 minutes 26 seconds |
| Uprooting of seedlings with machine [b] | 23 minutes 15 seconds |

a and b: Different letters refer to different groups.

When the results given in Table 7 were examined, it was found that the seedling uprooting process conducted with the machine was carried out in beech seedlings, which had a core root system and a sensitive development period, with much less damage, in a shorter time and with lower costs. When the fixed and variable costs of the machine used for seedling uprooting process and the cost of manpower were evaluated together, it is seen that machine operated work will be more economical, if uprooting of seedlings is carried out on approximately 182 seeding beds annually.

In a research conducted on this subject in important nurseries of England, it was found that the productivity increased up to 83.4%, when seedling uprooting was carried out using mechanization practices rather than the classical methods, and that the damage and injuries occurred during the uprooting of seedlings decreased by 64.7% (Aldhous and Mason, 1994). In addition, it was reported by Li et al. (2014) that the mechanized uprooting of seedlings had a positive effect on productivity and seedling quality.

## 4. Conclusions

A significant similarity was found between these results and the results obtained from the research carried out in the Gökçebey Forest Nursery, and that the mechanization provided significant time and cost efficiency, especially at the seedling uprooting and transportation stages. According to the examinations and evaluations made, the use of appropriate mechanization techniques positively affected and supported the nursery production activities because of the fact that it ensured shorter time, healthier and lower costs, production with a minimum loss, and uninterrupted production. Similarly, *Pinus radiata* production in nurseries in New Zealand was 1 million in 1962, with the development of mechanization in 1967, it reached 6 million (Gleed, 1967). For this reason, considering their ecological conditions, adoption of mechanization practices by making necessary preliminary surveys in the state-owned and private nurseries operating in different regions of Turkey is not only important in terms of production works, low cost and time saving, it is also important for the level of success of sowing activities carried out in urban and forest areas. Utilization of appropriate mechanization techniques determined in accordance with the necessary criteria at the seedling production stages and rehabilitation works in order to ensure the contribution of the forest areas, which are now destroyed due to various reasons, to the national economy, and to realize the forestry policies and targets in a timely manner, will always increase the success, and it will create an important opportunity for preventing a significant portion of occupational accidents that emerge, while applying classical methods.

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